Stabilised Power Supplies

PM 31-36

Instruction Manual

ADVANCE

C6-S1-006

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Instruction Manual

ADVANCE
INDUSTRIAL
ELECTRONICS

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PM31-36 provides D.C. output from 4-30V at current ratings up to 10A. The units are constructed on a modular basis with all units rated at 5A and below having a common front panel area 5" high and 4¼" wide. 10A units have 5" high x 5¼" wide front panels.

The output voltage of the unit is determined during manufacture by resistor selection but a front panel control allows a minimum of 0.5V variation either side of the nominal voltage. Stabilisation is achieved by a D.C. closed loop regulator using silicon series regulator transistors.

The units are fully protected against external short circuit and overloading by an auto reset (re-entrant) protection circuit.

Input Voltage

100,105, 110, 115, 120, 125, 200, 210, 220, 230, 240, 250v ±10% 48 to 450 Hz

	PM31	PM32	PM33	PM34	PM35	PM36
Output Voltage	4-30v	4-30v	4-30v	4-30v	4-15v	4-15v
Output Current	1A	3A	5A	10A	5A	10A

Line Regulation

Less than ± (0.01% + 1mV) for a ± 10% AC line variation at any specified tap, for 8-30V setting; ± (0.01% + 3mV) for 4-7V setting.

Load Regulation

PM31-34 Less than 0.05% for a no load to full load change for 8-30V setting; (0.05% + 5mV) for 4-7V setting.
PM35 and 36 Less than 0.1% for a no load to full load change for 8-15V setting; (0.1% + 10mV) for 4-7V setting.

Ripple

Less than 1mv pk-pk at full load.

Temperature Coefficient

Less than 0.02% per °C.

Output Impedance

Less than 0.25Ω at 100 KHz.

Protection

Auto-resetting over current protection set to between 115-120% of full load with limited short-circuit current of approximately 10%.

Temperature Range

−10° to 60°C.

Parallel Operation

All units can be operated in parallel up to 5 units and a special terminal is provided on the terminal block to facilitate slave operation.

Series Operation

Series operation requires the provision of external diodes and use of sequential switch-on.

External Control and Metering

'DC Link' is provided which may be utilised for remote switching, standby operation, or metering.

Insulation

Floating output must not exceed ± 250v DC from ground. Input tested at 500v DC live to ground, and live to output, greater than 10MΩ.

3.1 INSTALLATION

The modules can be secured in position by means of 4 off 10-32 UNF bolts which screw into floating captive nuts on centre as indicated in Fig.1.

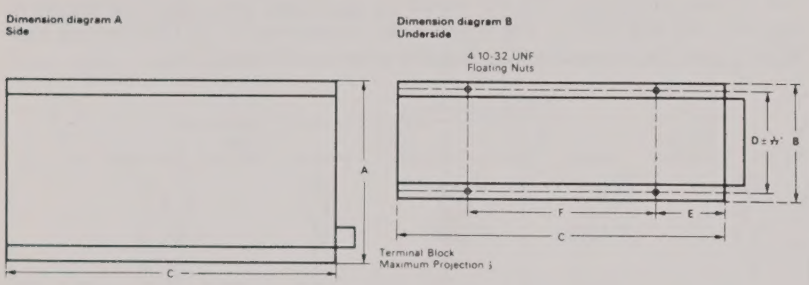


Fig.1

Table 1 PM31-36 DIMENSIONS

Type	Height A±1/64"		Width B±1/32"		Length C±1/32"		D		E		F		Weights	
PM	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	lb	kg
31	5	12.70	4 1/4	10.80	5 1/4	13.33	3 1/2	8.89	1	2.54	3	7.62	6	2.2
32	5	12.70	4 1/4	10.80	11 3/8	28.90	3 1/2	8.89	3 7/8	9.84	4 1/8	10.48	14.5	6.6
33	5	12.70	4 1/4	10.80	14 1/8	34.88	3 1/2	8.89	3 7/8	9.84	5 1/8	13.02	19.5	9.0
34	5	12.70	5 1/4	13.33	17 1/4	42.82	4 1/2	11.33	4 1/4	10.80	6 3/4	17.15	20.5	9.3
35	5	12.70	4 1/4	10.80	11 3/8	28.90	3 1/2	8.89	3 7/8	9.84	4 1/8	10.48	14.5	6.6
36	5	12.70	5 1/4	13.33	14 1/4	35.20	4 1/2	11.33	4 1/4	10.80	4 7/8	12.38	21.5	9.8

3.2 A.C. SUPPLY

Before connecting the unit ensure that the connections to the primary of the transformer are correct for the local supply and that the line fuse FS1 is correct for the line voltage (See table 4).

The primary connections of T1 should be paralleled when the local supply is between 100 and 125V. Fig.2 shows the connections for a 110V supply and Table 2 gives the connections for supplies between 100 and 125V.

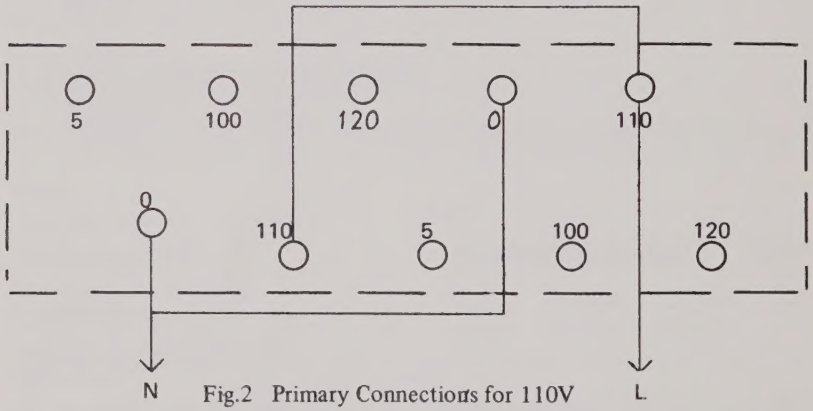


Fig.2 Primary Connections for 110V

For PM's 31, 34 and 36, the Primary connections are the same but with a different terminal board configuration.

Table 2 Transformer Primary connections 100V – 125V

Supply	Neutral	Line	Neutral link between	Line link between
100V	0	100	0 – 0	100 – 100
105V	5	100	5 – 5	100 – 100
110V	0	110	0 – 0	110 – 110
115V	5	110	5 – 5	110 – 110
120V	0	120	0 – 0	120 – 120
125V	5	120	5 – 5	120 – 120

When a 200-250V supply is available the primary connections of the transformer should be made in series. Fig.3 shows the connections for a 240V supply and Table 3 gives the connections for supplies between 200-250V

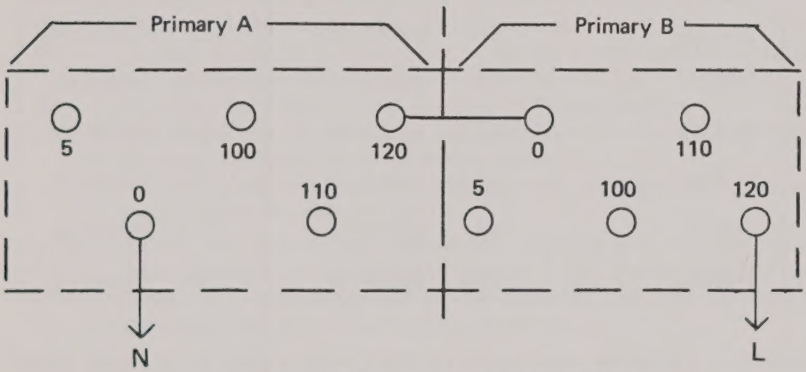


Fig 3 Primary connections for 240V

For PM's 31, 34 and 36 the Primary connections are the same but with a different terminal board configuration.

Table 3 **Transformer Primary connections 200V – 250V**

Supply	Neutral to primary A	Line to primary B	Link between Pri. A Pri. B
200V	0	100	100 – 0
210V	5	100	100 – 5
220V	0	110	110 – 0
230V	5	110	110 – 5
240V	0	120	120 – 0
250V	5	120	120 – 5

Table 4 Fuse Ratings

Power Module	Fuse rating 200 - 250V	Fuse rating 100 - 125V
PM31	2A (size oo)	4A (size oo)
PM32	5A (size o)	10A (size o)
PM33	7A (size o)	15A (size o)
PM34	10A (size o)	15A (size o)
PM35	5A (size o)	10A (size o)
PM36	10A (size o)	15A (size o)

NOTE:– The above fuses should be H.R.C. type except for 15 Amp. rating.

3.3 SETTING THE OUTPUT VOLTAGE

The unit is factory preset to the voltage indicated on the serial number panel with a further ±0.5V available on the SET OUTPUT VOLTS control. Although this control will generally give a greater variation this facility should be used with caution as the current limit setting varies in proportion to the output voltage and variations of more than 0.5V may cause a deterioration in performance at full load current especially at lower voltage settings.

If it is necessary to change the output voltage from the factory preset value proceed as follows:–

(1) Switch off the D.C. Supply.
(2) Set up the connections on the secondary side of the transformers in accordance with the information provided in Tables 5 and 6.
(3) When converting a 4-7V unit to an output between 8 and 30V it is necessary to remove Link A on the Printed Circuit Board.
(4) When converting an 8-30V unit to an output between 4 and 7V it is necessary to add Link A and R8, R9, MR2, MR3 and VT5 if these have not been fitted during manufacture.
(5) Replace R6, R7, R11, R14 and R15 in accordance with the information given in Tables 5 and 6.

(6) Ensure that the following terminals on the front panel are connected.

(a) DC LINK
(b) + S & +
(c) - S & -

(7) Connect a voltmeter between -S & +S terminals.

(8) Connect a variable resistance box across the pins provided for R12 and set this to greater than 10 times the value of R11.

(9) Turn the "Set Output Volts" controls to its mid position.

(10) Switch the unit on and reduce the resistance of the resistance box until the output voltage falls to the desired value.
NOTE: the value of the resistance box will generally be greater than 2 times the value of R11.

(11) Switch the unit off and replace the resistance box with the nearest preferred value of resistor (Metal Oxide Type) chosen from the E24 range. Switch the unit on and using the front panel control set the output voltage to exactly the required value.

3.4 SETTING UP THE CURRENT LIMIT CIRCUIT

(1) Ensure that the correct value of R6 has been fitted and connect a variable resistance box across the pins provided for R5. Set the resistance box to greater than 10 times the value of R6.

(2) Connect an ammeter in series with an adjustable load across the output terminals and slowly decrease the value of the resistance box until the maximum output current is 118% of the rated full load current.

(3) Set the resistance box to the nearest preferred value in the E24 range.

(4) Slowly increase the load current and check that its maximum value lies between 115% and 120% full load. If necessary re-adjust the resistance box to a preferred value remembering that an increase in resistance value reduces the maximum current and vice versa.

(5) Replace the resistance box with a fixed resistor connected across the R5 pins. This resistor can be either Metal oxide type or $\frac{1}{8}$ watt cracked carbon. Check that the maximum current remains between 115% and 120% full load.

3.5 UNIT CONNECTIONS

Tables 5 and 6 show the connections that should be made to the secondary windings of T1 and the values of R6, R7, R11, R14 and R15 which should be inserted. All these resistors are located on the printed circuit board.

Table 5 Voltage Adjustments for PM31–34 (4–30 Volts)

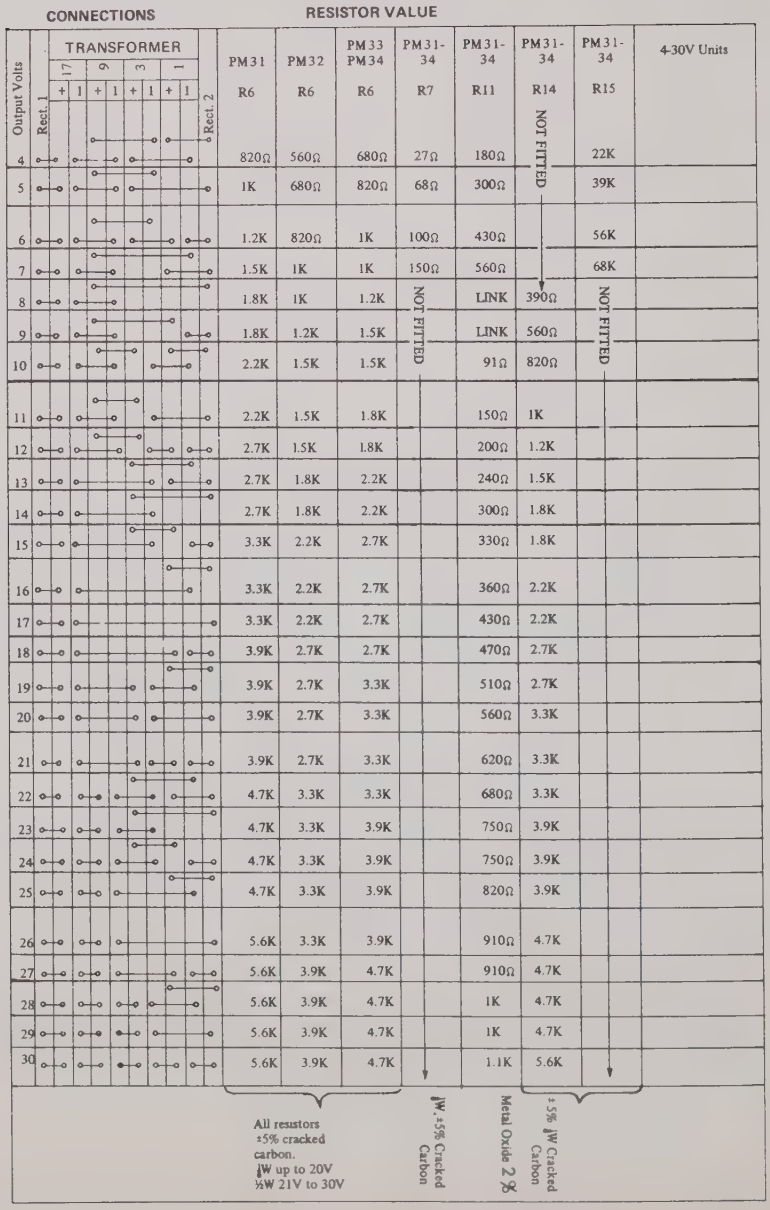
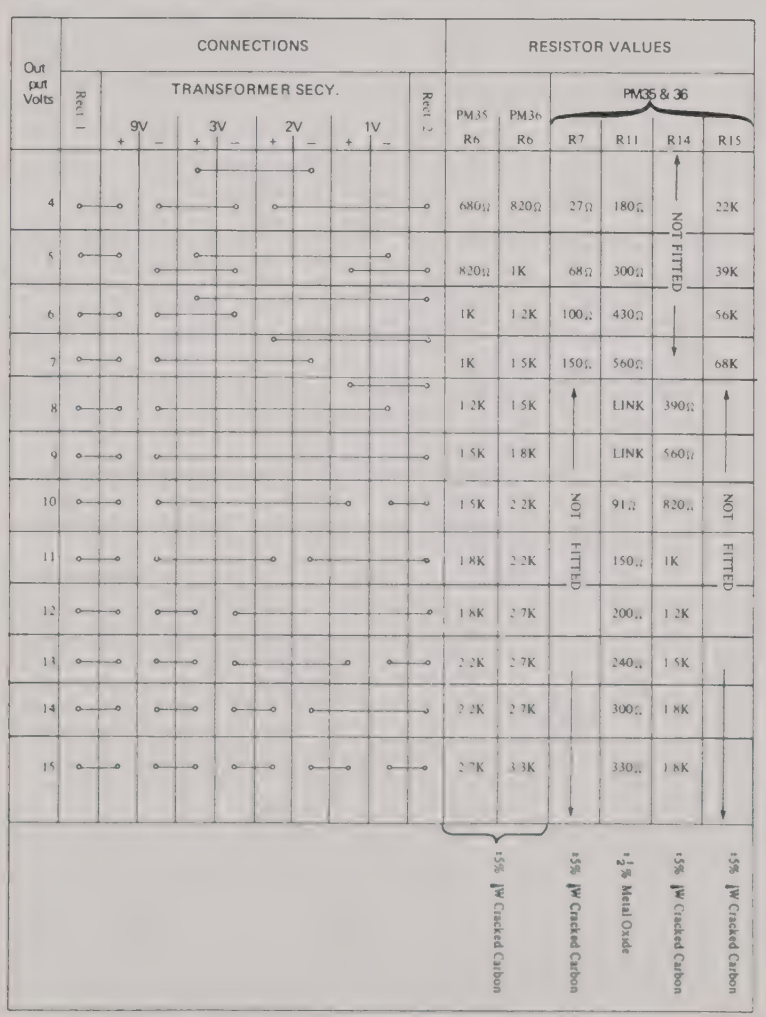


Table 6 Voltage Adjustments for PM35–36 (4–15V Units)



3.6 PARALLEL AND SLAVE OPERATION

Any combination of these units up to 5 off total can be operated in parallel by joining together the 'P' terminal on the front panel. Under these circumstances the unit set to the highest output voltage takes control with the other units acting as slaves.

3.7 SERIES OPERATION

The unit can be operated in series provided the following conditions are observed.

(1) The units must be set up to the required operating conditions as outlined in para. 3.3, 3.4, 3.5.
(2) The maximum current available will not exceed that available from the unit with the lowest current rating.
(3) A diode, of the same current and voltage rating of the module must be connected across each power module output. (Positive end of the diode to positive output terminal of the unit.)
(4) The supply must be switched on at least 200mS before the load is applied.
(5) To reset the cut-out it is necessary to switch off and switch on again as in (4).
(6) The total output voltage must not exceed 250V.

3.8 GENERAL PRECAUTIONS

(1) When these units are used in conjunction with power supplies of opposite polarity, provision must be made as in 3.7(3) above to protect the P.M. against reverse voltage conditions. The diode used must be of sufficient rating to carry the fault current generated.
(2) Where two supplies are used to give +ve and -ve voltages about a common rail the precautions given in 3.7(1), 3.7(3) to 3.7(5) and 3.8(1) must be observed if the current flowing out of one supply into the other exceeds 5% of the current rating of the supply having the lower rating.

3.9 FOUR-TERMINAL SENSING

Where long external output leads are used, four-terminal sensing is provided to enable the load voltage regulation of the power supply to be maintained at the load connections. The two links between the +ve output and the +ve sense, and the -ve output and the -ve sense terminals should be removed and connections made as shown in Fig.4. These output connections should be run together and a decoupling capacitor, similar to C103 in the power supply, connected at the load terminals if the high frequency output impedance is to be maintained. Parallel connection should be made as shown in Fig.5.

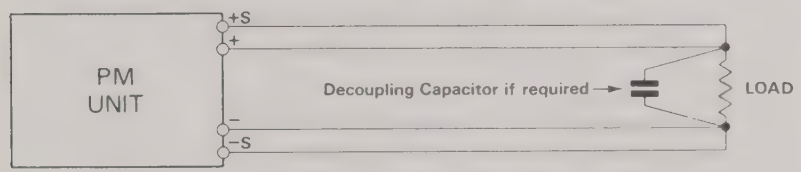


Fig.4 Four-Terminal Sensing

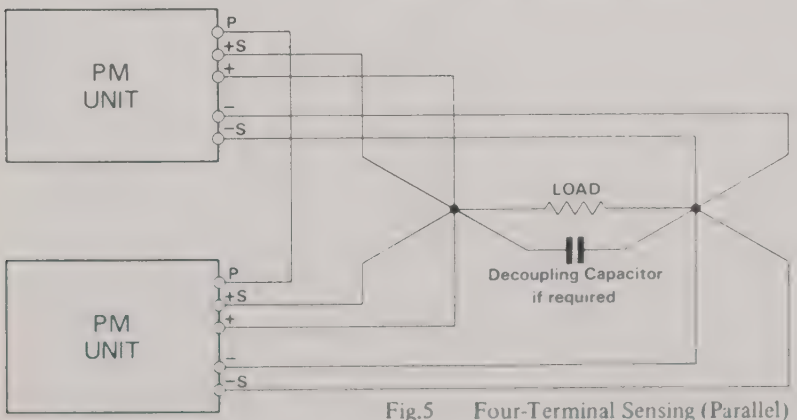


Fig.5 Four-Terminal Sensing (Parallel)

The maximum permissible voltage drop in the external leads when using four-terminal sensing is 0.5V total in both leads, i.e. 0.25V in each lead +ve and -ve or 0.5V in one supply lead with a ground return of negligible resistance. The total permissible length of lead for 0.5V drop is listed in Table 7 for various wire sizes and current ratings. Note that this is the total permissible loop length "go and return" and that the power supply can only be situated at half this distance from the load for a two wire +ve and -ve system.

Table 7 Permissible Lead Length for Four-Terminal Sensing

Wire Size	Lead Length (feet and metres)							
	PM31		PM32		PM33 & 35		PM34 & 36	
	ft	m	ft	m	ft	m	ft	m
7/0076	19	6						
14/0076	38	12	13	4				
23/0076	60	18	20	6	12	3.5		
40/0076			68	21	21	6.5	10	3
70/0076					37	11	18	5.5
110/0076					58	18	29	9
162/0076							43	13

4.1 GENERAL

The basic circuit of all modular power supplies in the PM31-36 range is the same. Differences due to current rating occur only in the quantity and type of the power transistors and smoothing capacitors. Differences between 4-7V units and those operating at high voltages are explained in later paragraphs.

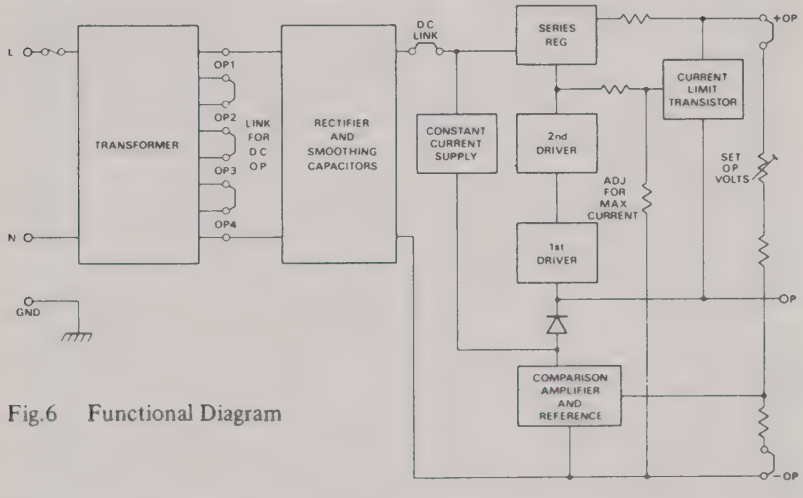


Fig.6 Functional Diagram

4.2 SUPPLY RECTIFICATION AND SMOOTHING

(See also Figures 8 & 9)

The 100-250V, 48-450Hz A.C. input is applied to the appropriate section of the primary winding of T1 through the supply input adjusting links and F.S.1. The four secondary windings on T1 provide A.C. voltages which are combined, rectified and smoothed to provide the input voltage to the regulators appropriate to the required output voltage. This is achieved by connecting each winding either in "buck" or "boost" in accordance with Tables 5 & 6. In this way a voltage of the desired amplitude is obtained for the bridge rectifier MR6. The full wave output from MR6 is smoothed by C102, R101 acting as a bleed resistor. The smoothed output is taken through the D.C. link to the collectors of the series regulators VT8.

The D.C. link should be removed if remote control of the output is required by means of a fuse, switch or power relay contact.

4.3 VOLTAGE CONTROL

(a) 4-7V Units (See Figures 8 & 9)

Voltage control of the 4-7V units is achieved by means of a long tailed pair VT5 and VT6. In this circuit Zener Diode MR2, Diode MR3, and Resistors R7 and R8 provide a temperature compensated, stable reference voltage. R7 is adjusted according to voltage to maintain a current of approximately 30mA through MR3. R9 is the common emitter resistor but MR5 is redundant since it has a zener voltage of 6.2V while the voltage across it is only approximately 1.8V. This is obtained from the 2.7V zener MR2 via diode MR3 and the base emitter diode of VT.5. R15 is used to provide current feedback at low voltages to improve the output voltage regulation.

The collector of VT6 is supplied by the constant current regulator MR1, C1, R1, R2, VT1 & VT2. MR1 and C1 form a peak rectifier circuit which provides a voltage equal to the peak of the ripple obtained from the smoothing capacitors. The value of the constant current from VT2 is fixed at approximately 1mA and is determined only by the value of R1 and the base-emitter voltage of VT1. Any tendency for this current to increase would cause VT1 to pass more current thus reducing the current into the base of VT2 and reducing the collector current of VT2 to its original value.

A portion of the output voltage is applied to the base of VT6 via the potentiometer chain RV1, R11, R12 and R13. Any increase in the output voltage causes the base of VT6 to go more positive with respect to its emitter causing it to take more current from VT2. This allows less current to flow into the base of VT3, via MR4, which reduces the current flowing through the regulators thus maintaining the output voltage at its original value.

Diode MR4 is normally conducting but if units are operated in parallel with their P points connected, the unit which is set to give the greatest output voltage will turn off these diodes in the other units thus disconnecting the amplifiers from other drivers and taking control. Capacitor C4 helps to reduce the output ripple.

(b) 8-30V Units (See Figures 8 & 9)

When units are supplied for use between 8 and 30V, link A and the following components are not normally fitted:- R7, R8, R9, MR2 and VT5. The operation of the circuit is as given in para. 4.3(a), except that a single-ended amplifier is used and zener reference MR5 is chosen to have a positive temperature co-efficient equal to the negative co-efficient of the base emitter diode of MT6. Any increase in output voltage increases the base emitter voltages of VT6 and reduces the drive available for VT3 as before.

4.4 CURRENT LIMIT CIRCUIT

(See Figures 7, 8 & 9)

The regulator transistors are protected from damage due to current overloads by a re-entrant current limiting circuit.

A current flows through R5 and R6 and produces a reference voltage across R4 which is proportional to the output voltage. As the load resistance is reduced the output current increases until the voltage across R102 exceeds that across R4, and VT4 is driven into conduction reducing the drive to VT3 and thus reducing the output voltage. Because the output voltage is now less than that to which the amplifier is set, VT6 cuts off and control is transferred to VT4.

Further reductions in load resistance reduces the voltage across R5 and R6 and hence the reference voltage across R4. Thus the available output current decreases as the load resistance is reduced giving a re-entrant characteristic as shown in Figure 7.

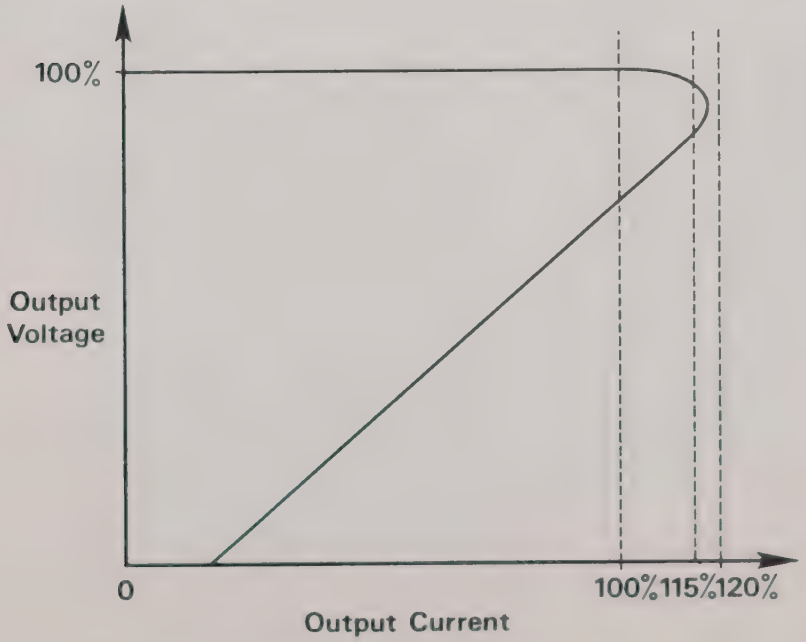


Fig.7 Output voltage plotted against output current

5.1 ACCESS TO COMPONENTS

Components which require to be adjusted during a setting up procedure are all located on the printed circuit board and are accessible without any dismantling. In order to obtain access to components on the heatsinks or change components on the printed circuit board, the top angles should first be removed.

5.2 FAULT FINDING

Determine the state of the output voltage on load and proceed as outlined in Table 8.

Table 8 Fault Finding Chart

Output Voltage	Possible Faults	Action
Zero	Fuse blown. MR6 faulty. D.C. link open circuit.	Replace fuse Replace MR6. Tighten screws or replace link
	VT7 & VT8 open circuit.	Replace as appropriate.
	Transistor on P.C. faulty	Replace appropriate transistor.
	Wire or transformer links open circuit	Re-make joint
	Wire to P.C. open circuit	Re-make joint
Low Output	MR6 partially open circuit	Change MR6.
	Component on P.C. faulty	Replace appropriate component
	Transformer taps incorrectly adjust	Re-adjust taps

Table 8 Fault Finding Chart (continued)

Output Voltage	Possible Faults	Action
High unstabilised output with high ripple	Current limit operative	Adjust values of R5 & R6 as necessary.
	Incorrect value of R11 & R12	Adjust values of R11 & R12 as necessary
	VT7 and VT8 short circuit	Replace appropriate transistor.
	Component on P.C. Board faulty	Replace appropriate component
	R11 & R12 open circuit or incorrect value.	Replace resistors as appropriate

The main components are listed below. Components on the printed circuit board are listed separately. Items marked * may be omitted on units manufactured for use between 8 and 30V output. Alternative manufacturers components may be used according to availability.

PM31

Ref	Value	Description	Part No.
RV1	150	Welwyn Potentiometer GYP22	26033
C102	1000μF	Capacitor 70V DC Electrolytic Dubilier CT4916	26030
C103	250μF	Capacitor 40V DC Electrolytic Mullard C437	26031
VT8		2N3055	3813
T1		Transformer	MT585
FS1:- 200-250V	2A	Fuse Belling Lee L754	1255
100-125V	4A	Fuse Belling Lee L562	5120

PM32

R101	1K±10%	Resistor Erie type Z24W	26036
R102	2x1.2Ω ±10%	Resistor Erie type Z24W	26032
RV1	150	Welwyn Potentiometer GYP22	26033
C101	0.1μF	Capacitor 160V Mullard C296	804
C102	4000μF	Capacitor 70V Dubilier S/CT 4885	26040
C103	800μF	Capacitor 40V Mullard C431	2799
MR6		Rect. Bridge Texas 1B40K20	17763
VT7		Transistor RCA40250	4224
VT8		Transistor 2 X 2N 3055	3813
T1		Transformer	MT586
FS1 - 200-250V	5A	Fuse Belling Lee L693	638
100-125V	10A	Fuse Belling Lee L693	4227

PM33

R101	1K±10%	Resistor Erie Type Z24W	26036
R102	4x1.2 ±10%	Resistor Erie Type 2400/Z2 4W	26032
RV1	150	Potentiometer Welwyn GYP22	26033
C101	0.1μF	Capacitor 160V Mullard C296	804
C102	7000μF	Capacitor 70V Dubilier S/CT	26039
C103	800μF	Capacitor 40V Mullard C431	2799
MR6		Rect. Bridge SEMTEC SCBA2	22721
VT7		Transistor RCA 40250	4224
VT8		Transistor 4X2N 3055	3813
T1		Transformer	MT587
FS1:- 200-250V	7A	Fuse Belling Lee L693	13040
100-125V	15A	Fuse Belling Lee L693	964

PM34

R101	1K±10%	Resistor Erie type Z24W	26036
R102	8x1.2 ±10%	Resistor Erie type Z24W	26032
RV1	150	Potentiometer Welwyn GYP22	26033
C101	0.1μF	Capacitor 160V Mullard C296	804
C102	2 x 7000μF	Capacitor 70V Dubilier S/CT	26039
C103	2500μF	Capacitor 40V Mullard C431	484[illegible]
MR6		Lucas 2 x DD6123	27214
		2 x DD6123A	27215
VT7		Transistor 2N3055	3813
VT8		Transistor 8 x 2N3055	3813
T1		Transformer	MT1000
FS1:- 200-250V	10A	Fuse Belling Lee L693	4227
100-125V	15A	Fuse Belling Lee L1055	961

PM35

R101	1K±10%	Resistor Erie type Z24W	26036
R102	2 x 0.56 ±5%	Resistor wirewound	23068
RV1	150	Potentiometer Welwyn GYP22	26033
C101	0.1μF	Capacitor 160V Mullard C296	804
C102	10000μF	Capacitor 50V Dubilier S/CT3610	26038
C103	1250μF	Capacitor 16V Mullard C431	18816
MR6		Rect. Bridge SEMTEC SCBA2	22721
VT7		Transistor RCA 40250	4224
VT8		Transistor 2 x 2N3055	3813
T1		Transformer	MT589

Ref	Value	Description	Part No
FS1 -			
200-250V	5A	Belling Lee L693	638
100-125V	10A	Belling Lee L693	4227
PM36			
R101	1K±10%	Resistor Erie type Z2	26036
R102	5 x 0.56 ±5%	Resistor wirewound	23068
RV1	150	Potentiometer Welwyn GYP22	26033
C101	0.1μF	Capacitor 160V Mullard C296	804
C102	10000μF	Capacitor 50V Dubilier S/CT3610	26038
C103	2000μF	Capacitor 16V Mullard C431	2800
MR6		Lucas	
		2 x DD6123	27214
		2 x DD6123A	27215
VT7		Transistor 2N3055	3813
VT8		6 x Transistor 2N3055	3813
T1		Transformer	MT590
FS1 -			
200-250V	10A	Fuse Belling Lee L693	4227
100-125V	15A	Fuse Belling Lee L1055	964

PM31 Printed Circuit Board (Assy No 25977)

RESISTORS (5% 1/8W Cr. Carbon unless specified)

R1	680		309
R3	33K		317
R3	3.3K ±5%	½W Cracked	18556
R4	220		304
R5	AOT	1/8W Cr. Carbon Metal Oxide	
R6	See Table 5		
R7	See Table 5		
*R8	560		308
*R9	1K		384
R10	56		2411
R11	See Table 5		
R12	AOT ±2%	Metal Oxide	
R13	270 ±2%	Metal Oxide	26742
R14	See Table 5		
R15	See Table 5		
R101	4.7K	1W Cr. Carbon	4796
R102	1.2	6W Wirewound	4260
R103	100		11504
R104	100		11504

Ref	Value	Description	Part No
CAPACITORS			
C1	32μF	64V DC C426AR/H32	20777
C2	0.1μF	160V C296 AA/A	804
C3	0.01μF	160V C296 AA/A	802
C4	10μF	64V C426 AR/H10	20774
C101	0.01μF	160V C296 AA/A	802
DIODES			
MR1		AEI MS4H	20422
*MR2		Zener Diode ZF2.7	21002
*MR3		AEI MS1H	18806
MR4		AEI MS4H	20422
MR5		Zener Diode ZF6.2	4032
MR6		Pirelli Rect Bridge W02	19725
TRANSISTORS			
VT1		Micro-Electronics ME 0413	26062
VT2		Mullard BCY30	23704
VT3		RCA 2N3053	4039
VT4		Texas Instruments 2S745A	20831
*VT5		Texas Instruments 2S745A	20831
VT6		Texas Instruments 2S745A	20831
VT7		RCA 2N3053	4039

PM32-36 Printed Circuit Board (Assy No 25975)

RESISTORS (5% 1/8W Cr. Carbon unless specified)

R1	680		309
R2	33K		317
R3	3.3K ±5%	½W Cr. Carbon	18556
R4	220		304
R5	AOT		
R6) R7)	See Table 5 (PM32-34) or Table 6 (PM35-36)		
*R8	560		308
*R9	1K		384
*R10	100		11504
R11	See Table 5 (PM32-34) or Table 6 (PM35-36)		
R12	AOT ±2%	Metal Oxide	
R13	270 ±2%	Metal Oxide	26742
R14) R15)	See Table 5 (PM32-34) or Table 6 (PM35-36)		
R103	100		11504
R104	100		11504

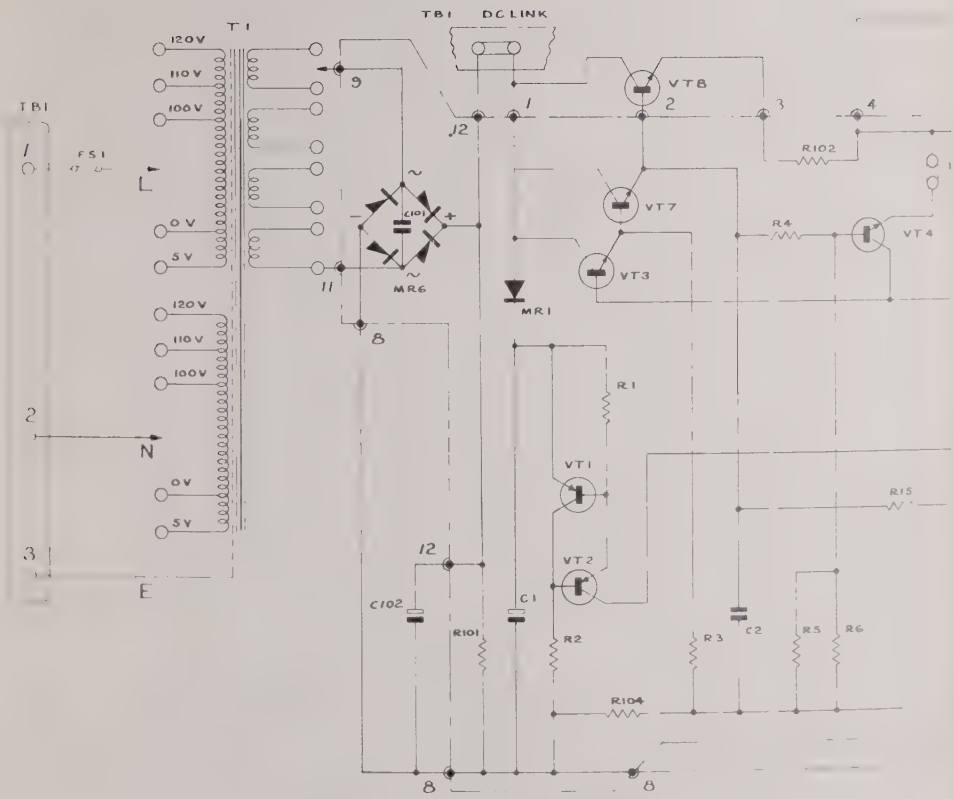
Ref	Value	Description	Part No
CAPACITORS (All Mullard)			
C1	32μF	64V DC C426 AR/H32	20777
C2	0.1μF	160V C296 AA/A	804
C3	0.01μF	160V C296 AA/A	802
C4	10μF	64V DC C426 AR/H10	20774
DIODES			
MR1		AEI MS4H	20422
*MR2		Zener Diode ZF2.7	21002
*MR3		AEI MS1H	18806
MR4		AEI MS4H	20422
MR5		Zener Diode ZF6.2	4032
TRANSISTORS			
VT1		Micro-Electronics ME 0413	26062
VT2		Mullard BCY30	23704
VT3		RCA 2N3053	4039
VT4		Texas Instruments 2S745A	20831
*VT5		Texas Instruments 2S745A	20831
VT6		Texas Instruments 2S745A	20831

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than tubes, semiconductors and fuses. Tubes and semiconductors are subject to the manufacturers' guarantee.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The type and serial number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.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DC LINK
T1
120V
110V
100V
0V
5V
FS1
C101
MR6
MR1
VT8
VT7
VT3
VT4
R102
R4
R1
VT1
VT2
R15
C102
R101
C1
R2
R3
C2
R5
R6
R104
9
11
8
12
1
2
3
4
J2

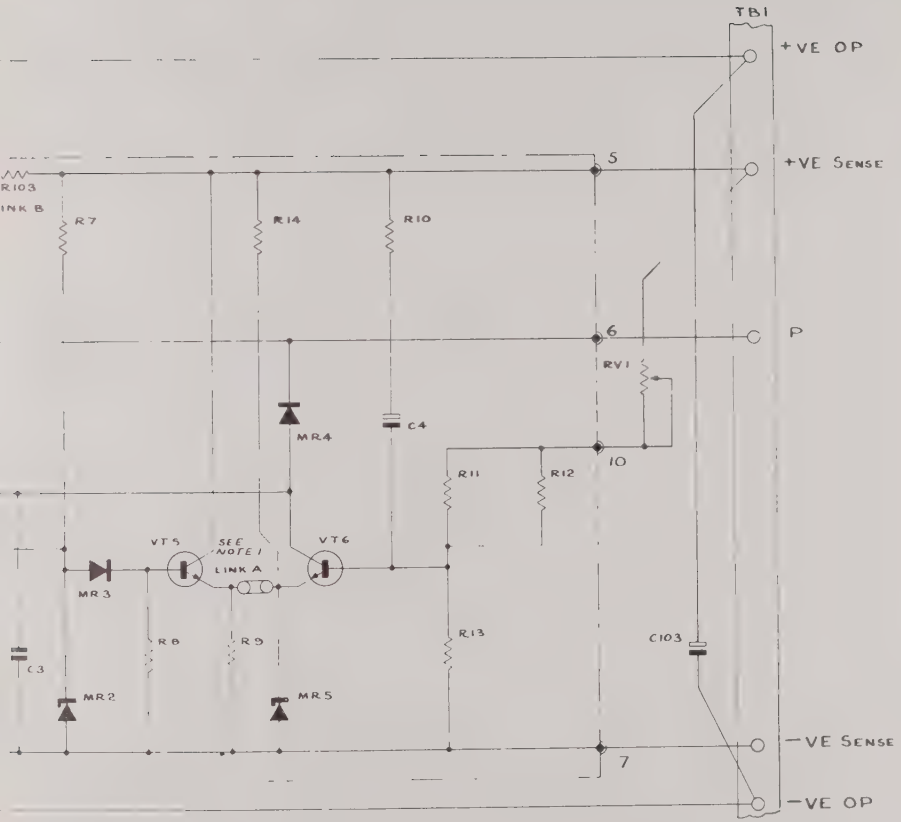
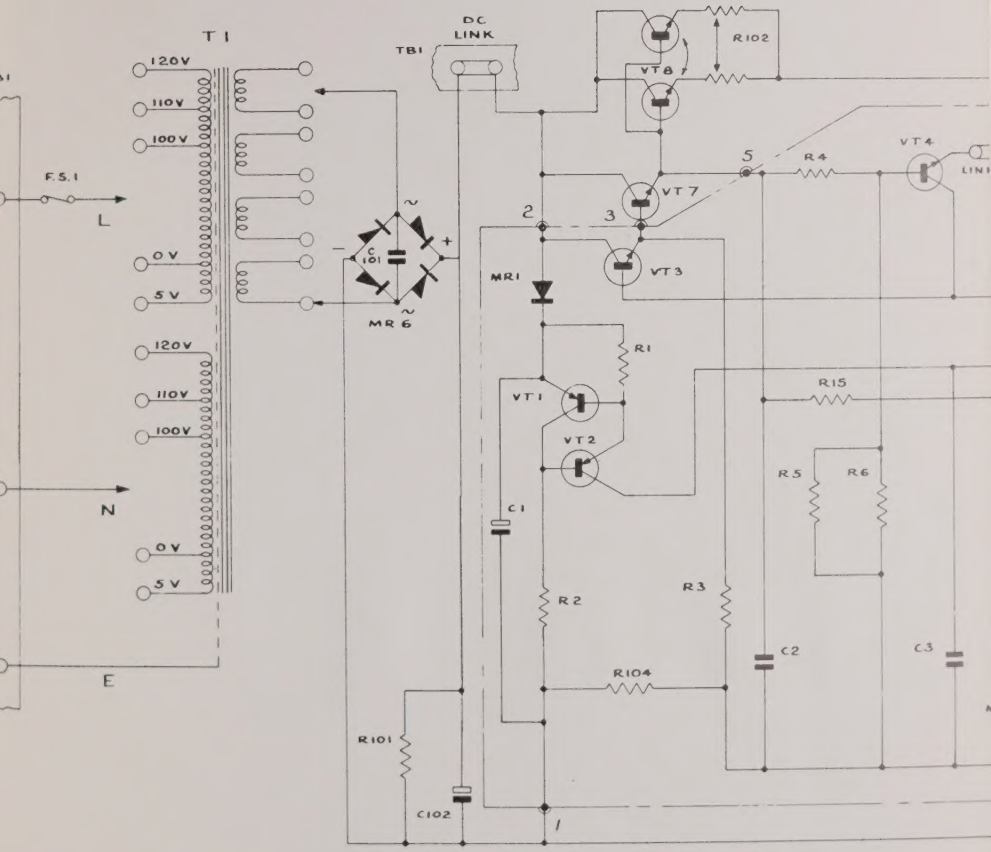


Fig.8 Circuit Diagram PM31


T1
120V
110V
100V
0V
5V
120V
110V
100V
0V
5V
F.S.1
L
N
E
TB1
DC LINK
C 101
MR6
MR1
VT1
VT2
VT3
VT7
VT8
VT4
R1
R2
R3
R4
R5
R6
R15
R101
R102
R104
C1
C2
C3
C102
1
2
3
5

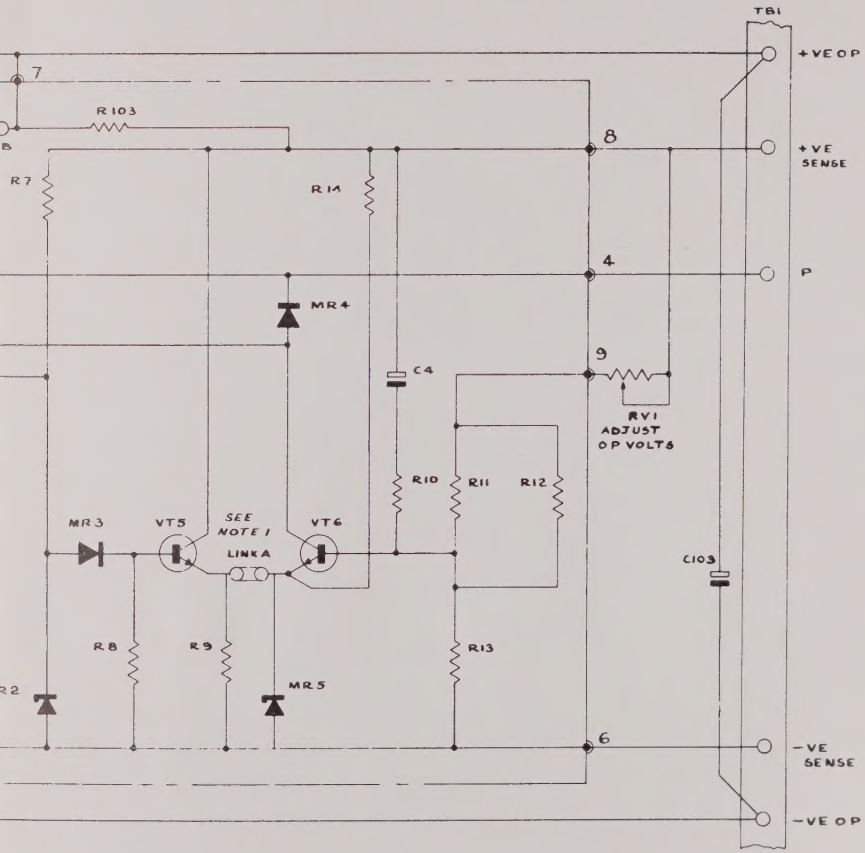


Fig.9 Circuit Diagram PM32-36

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